

Chitinozoan stratigraphy in the Ashgill and Llandovery

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Synopsis

There is little published information on chitinozoan faunas from sections with continuous sedimentation across the Ordovician–Silurian boundary. Most boundary sections from which chitinozoans have been described include a hiatus. To aid determination of the extent of any hiatus, the ranges of thirty-one diagnostic chitinozoan species from Ashgill and Llandovery strata are documented, with reference to the British standard graptolite zonation. The composition of the chitinozoan faunas at the Ordovician–Silurian boundary is discussed, and the influence of ecological factors is assessed.

Introduction

Chitinozoans are organic-walled microfossils known from marine sedimentary rocks of Ordovician to Devonian age. Although pertinent information is missing from, for instance, Australia and the East Indies, it is no exaggeration to say that chitinozoans have great stratigraphical potential on a world-wide basis. However, our knowledge of the chitinozoan faunas at the Ordovician–Silurian boundary is still scanty. Chitinozoans from sections with continuous sedimentation across the boundary are known only from Anticosti Island, Québec (Achab 1981), Skåne, Sweden (Grahn 1978) and probably Estonia (Nestor 1976, 1980*a*, 1980*b*, and personal communication 1985; Nölvak 1980, and personal communication 1985). Faunas from sections with a small hiatus have been described from Libya (Molyneux & Paris 1985; Hill *et al.* 1985), the Cincinnati Region, midcontinent U.S.A. (Grahn 1985; Grahn & Bergström 1985; M. A. Miller, personal communication 1985) and the Brabant Massif, Belgium (Martin 1973). References to other papers with relevant data on Ashgill and/or Llandovery chitinozoan faunas will be made in context. To help in determining the extent of any hiatus, the ranges of selected chitinozoan species from the early Ashgill to the late Llandovery are documented here. The total range of each species (Fig. 1) is defined according to the British standards for the Ashgill (*sensu* Williams 1983) and Llandovery (*sensu* Cocks *et al.* 1984) Series.

Diagnostic Ashgill chitinozoans

Many Ashgill chitinozoan species are long-ranging and persist from the middle or lower Ordovician. Only a few species are restricted to the Ashgill (Fig. 1). The chitinozoans can be divided into a pre-Hirnantian fauna, and a fauna that ranges into the Hirnantian (Figs 2–12). Ashgill chitinozoans from Great Britain are virtually unknown. The type Hirnantian is barren of chitinozoans. In older strata, *Tanuchitina bergstroemi* occurs in the Rawtheyan (F. Paris, personal communication 1985).

In North Africa *Armoricochitina nigerica* and *Calpichitina? lenticularis* are very characteristic for the late Ashgill (Elaouad-Debbaj 1984; Molyneux & Paris 1985; J. C. Jaglin, personal communication 1985). These species are also known from SW Europe (Paris 1981). *Acanthochitina? rashidi*, *Ancyrochitina merga*, *Plectochitina sylvanica*, and *Sphaerochitina lepta* characterize the Ashgill in midcontinent U.S.A. (Jenkins 1970; M. A. Miller, personal communication 1986, own observations). *Ancyrochitina merga* has a more spinose ornament in the lower Ashgill than higher, and all specimens of *Sphaerochitina lepta* are smooth in the mid-Ashgill but are joined by spinose forms in the upper Ashgill. No Hirnantian chitinozoans are known from the mid-continent U.S.A.

So far, *Conochitina gamachiana* has only been reported from the upper Ashgill strata of Anticosti Island (Achab 1978). Other typical associated species are *Ancyrochitina longispina*,

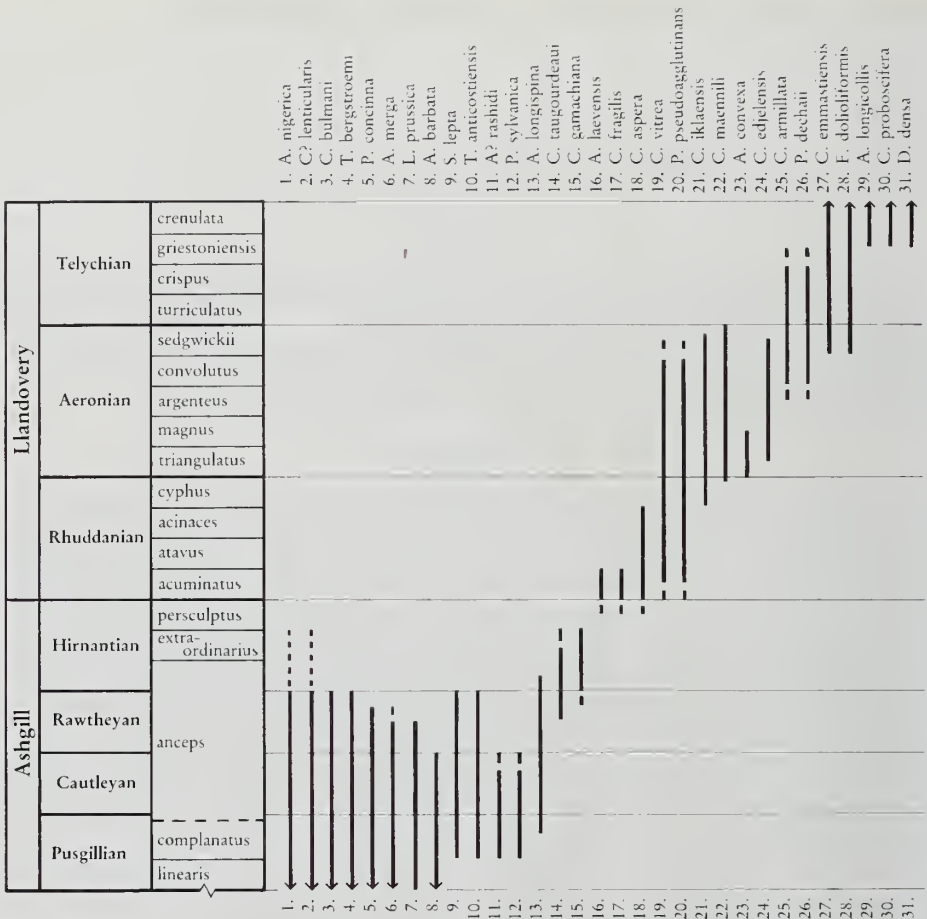
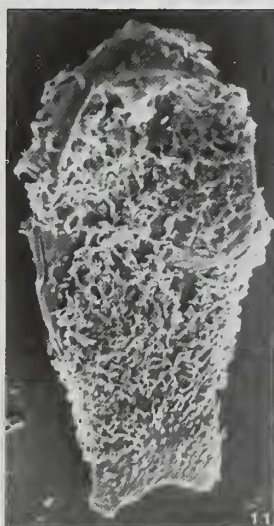


Fig. 1 Biostratigraphical ranges of selected chitinozoans from the Ashgill and Llandovery.

Figs 2–12 Selected Ashgill Chitinozoa. 2, *Tanuchitina anticostiensis*, Vauréal Formation (early Ashgill), boring RH5, Anticosti Island, Canada; SEM $\times$ 150. 3, *Calpichitina? lenticularis*, middle Caradoc–early Ashgill, boring E1-81 (791 m), Libya; SEM $\times$ 230. 4, *Armoricochitina nigerica*, late Caradoc–Ashgill, boring E1-81 (785–792 m), Libya; SEM $\times$ 190. 5, *Plectochitina sylvanica*, early Ashgill, boring J1-81A (3985–4000 m), Libya; SEM $\times$ 310. 6, *Sphaerochitina lepta*, Sylvan Shale (early Ashgill), Arbuckle Mountains, Oklahoma, U.S.A.; SEM $\times$ 345. 7, *Conochitina gamachiana*, Ellis Bay Formation (late Ashgill), boring A425, Anticosti Island, Canada; SEM $\times$ 270. 8, *Lagenochitina prussica*, Vormsi Stage (early Ashgill), Gotska Sandön boring (93.30–93.35 m), Sweden; SEM $\times$ 360. 9, *Tanuchitina bergstroemi*, erratic of late Caradoc age, Öland, Sweden; SEM $\times$ 130. 10, *Coronochitina taugourdeui*, Porkuni Stage (late Ashgill), Taagepera boring, Estonia; SEM $\times$ 225. 11, *Acanthochitina barbata*, Vormsi Stage (early Ashgill), Gotska Sandön boring (96.34–96.40 m), Sweden; SEM $\times$ 140. 12, *Plectochitina concinna*, Vauréal Formation (early Ashgill), boring AF6, Anticosti Island, Canada; SEM $\times$ 310.

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Coronochitina bulmani, *Plectochitina concinna*, and *Tanuchitina anticostiensis* (Achab 1978). In contrast to other areas, *Hercochitina* species are very common in the Ashgill of Anticosti Island and the midcontinent U.S.A.

Acanthochitina barbata is restricted to the upper *Pleurograptus linearis* Zone in Baltoscandia (Nölvak 1980), but has a slightly longer range in north Africa and North America. *Coronochitina taugourdeau* is another excellent index fossil. It is one of the few chitinozoan species indicative of the Hirnantian and is known from Baltoscandia and Anticosti Island (Eisenack 1968; Nölvak 1980; Achab 1981). *Lagenochitina prussica* and *Tanuchitina bergstroemi* are Baltoscandian species (Grahn 1982); the former is also known from the Ashgill in north Africa (Elaouad-Debbaj 1984; Molyneux & Paris 1985), the Brabant Massif, Belgium (Martin 1973; own observations) and Podolia, U.S.S.R. (Laufeld 1971).

Chitinozoan faunas at the Ordovician–Silurian boundary

Chitinozoan faunas at the Ordovician–Silurian boundary are characterized by a complex of *Ancyrochitina* (e.g. *A. ancyrea*, *A. spongiosa*) and *Cyathochitina* species (e.g. *C. campanulaeformis*, *C. kuckersiana*). Nestor (1980a) described *Conochitina postrobusta* from the Juuru Stage in Estonia. However, in Skåne, Sweden (Grahn 1978) and the Brabant Massif, Belgium (Martin 1973; own observations) there is no difference between late Ashgill and Llandovery specimens of *Conochitina robusta*. It is therefore uncertain whether *C. postrobusta* can be separated from Ashgill specimens of *C. robusta*.

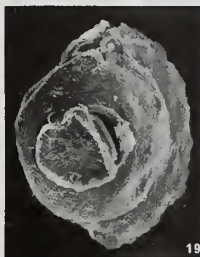
Some Ordovician genera (e.g. *Acanthochitina*, *Hercochitina*) and typical Ordovician species (e.g. *Desmochitina* gr. *minor*, *Conochitina* gr. *micracantha*) disappear in the top Ashgill, but most Ordovician genera persist into the Silurian. However, very few Ordovician species range into the Llandovery.

Diagnostic Llandovery chitinozoans

Silurian chitinozoans (Figs 13–27) are more widely distributed than Ordovician ones (Laufeld 1979). Endemic chitinozoan faunas do occur, but not to the same extent as during the Ordovician. However, there is a difference in chitinozoan assemblages between north Africa, Anticosti Island and Baltoscandia. Chitinozoans from the type Llandovery are poorly preserved and the diversity seems to be low (K. Dörning, personal communication 1985). On the other hand, Telychian faunas from Great Britain show a striking similarity to contemporaneous faunas in Baltoscandia (Aldridge *et al.* 1979; Dörning 1981; Mabillard & Aldridge 1985).

Figs 13–27 Selected Llandovery Chitinozoa. 13, *Coronochitina fragilis*, Juuru Stage (early Llandovery), Ohesaare boring (466.5 m), Estonia; SEM $\times 300$. 14, *Conochitina armillata*, middle-late Llandovery, boring D1-31 (1895–1896 m), Libya; SEM $\times 160$. 15, *Conochitina edjelensis elongata*, middle-late Llandovery, boring E1-81 (606–612 m), Libya; SEM $\times 160$. 16, *Eisenackitina dolioliformis*, Restevo Beds (late Llandovery), Podolia, U.S.S.R.; SEM $\times 420$. 17, *Conochitina aspera*, Juuru Stage (early Llandovery), Ikla boring (514.6 m), Estonia; SEM $\times 430$. 18, *Conochitina proboscifera*, Upper Visby Beds (early Wenlock), Gotland, Sweden; SEM $\times 70$. 19, *Pterochitina dechajii*, middle-late Llandovery, boring D1-31 (1895–1896 m), Libya; SEM $\times 325$. 20, *Plectochitina pseudoagglutinans*, middle-late Llandovery, boring A1-81 (1154–1161 m), Libya; SEM $\times 195$. 21, *Conochitina electa*, Raikküla Stage (middle Llandovery), Emmaste boring (41.2 m), Estonia; SEM $\times 160$. 22, *Angochitina longicollis*, Lower Visby Beds (late Llandovery), Gotland, Sweden; SEM $\times 175$. 23, *Conochitina iklensis*, Raikküla Stage (middle Llandovery), Ikla boring (492.0 m), Estonia; SEM $\times 160$. 24, *Coronochitina maennili*, Raikküla Stage (middle Llandovery), Ikla boring (462.9 m), Estonia; SEM $\times 160$. 25, *Ancyrochitina convexa*, Raikküla Stage (middle Llandovery), Ruhnu boring (536.0 m), Estonia; SEM $\times 300$. 26, *Desmochitina densa*, Upper Visby Beds (early Wenlock), Gotland, Sweden; SEM $\times 345$. 27, *Ancyrochitina laevis*, Juuru Stage (early Llandovery), Laeva boring (122.5 m), Estonia; SEM $\times 300$.

Figs 13, 17, 21, 23–25, 27 with permission of Viit Nestor (Tallinn), Figs 14–15, 19–20 with permission of Florentin Paris (Rennes) and Figs 16, 18, 22, 26 with permission of Sven Laufeld (Uppsala).



The appearance of *Ancyrochitina laevis* and *Coronochitina fragilis* indicates lowermost Rhuddanian strata (Nestor 1980a). Otherwise pre-cyphus beds have a low chitinozoan diversity, and, apart from *Conochitina aspera*, there are very few diagnostic species above the *acuminatus* Zone (Fig. 1). In the cyphus Zone *Conochitina iklaensis* occurs, and is joined in the topmost part by *Coronochitina maennili* (Nestor 1980a). These two species disappear in the *sedgwickii* Zone (Nestor 1980a; own observations) together with *Conochitina edjensis*, a useful representative of the Aeronian. The lowermost Aeronian is characterized by the presence of *Ancyrochitina convexa* (Nestor 1980b). *Eisenackitina dolioliformis* and *Conochitina emmastiensis* (Nestor 1982a) have their first appearance in the *sedgwickii* Zone and range into the Wenlock. A very characteristic chitinozoan assemblage occurs in the *griestoniensis* Zone, consisting of *Angochitina longicollis*, *Conochitina proboscifera* and *Desmochitina densa* and is widely distributed (Dorning 1981; Nestor 1982b; Verniers 1982; Mabillard & Aldridge 1985; etc.).

The presence of Baltoscandian species among north African chitinozoan assemblages makes it possible to determine the stratigraphical ranges of some north African taxa (Paris, in press), such as *Plectochitina pseudoagglutinans* and *Conochitina vitrea* (Hill *et al.* 1985). These species range from the lower Rhuddanian to the upper Aeronian (Fig. 1). Two other species, *Conochitina armillata* and *Pterochitina deichaii*, range from the mid-Aeronian to the mid-Telychian (Paris, in press).

Remarks on the boundary chitinozoans

In general the abundance and diversity of chitinozoans are comparatively low at the Ordovician–Silurian boundary, irrespective of geographic area. This is probably due to the Gondwana glaciation, which led to a eustatic sea-level drop, and the subsequent deposition of shallow-water sediments in many cratonic successions. Chitinozoans are usually rare or absent in rocks deposited in very shallow water (Laufeld 1974; Grahn & Bergström 1984, 1985). If chitinozoans are present in these rocks, planktic forms often dominate and these were probably transported inshore by currents and waves. This is demonstrated in the Belfast Beds of early Llandovery age in the Cincinnati Region, where the planktic genus *Ancyrochitina* constitutes about 99% of the chitinozoan fauna (Grahn & Bergström 1985).

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